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ABSTRACT

Strategy analysis systems (SAS) used to describe classroom instruction are characterized by three components: (1) observing classroom behavior; (2) coding behavior into categories; and (3) data reduction with translation into meaningful feedback. Unique learning environments (laboratories and inquiry teaching) have necessitated developing SAS unique to science. Although these instruments have elements in common, they differ on various conceptual and contextual dimensions. SAS include: (1) categorical-linear, such as behavior checklists, which use nominal or continuous data to determine the frequency of specific instructional behaviors but not the relative change along a given continuum; (2) descriptive, designed to record and measure observed behavior without assessing the quality of what is being observed; (3) evaluative, designed to assess type and quality of teaching behaviors; (4) specialized, developed to measure specific teaching strategies and processes; and (5) general, designed to measure generic teaching behaviors. Although designed for research purposes, SAS are also used in teacher education, including training in use of instruments, analyzing teaching models, practicing teaching skills (microteaching), analyzing lessons (self, peer, supervisor analysis), and in reteaching. Research results indicate the efficiency of strategy analysis employed in assessing classroom behavior and as a means for training preservice teachers in using these behaviors. (Author/JN)

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Using Behavior Analysis to Train Better Science Teachers: A Review of Research and Practice

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Strategy Analysis Instruments

Behavior analysis is a meta-language of instructional communication. It is a communication system designed to describe and analyze communication in learning environments (Simon and Boyer, 1974). Over the past twenty years numerous interaction analysis "languages" have been developed to describe classroom instruction. These observation systems have three common components; observing classroom behavior, coding the behavior into categories, and data reduction with translation into meaningful feedback.

One of the earliest developed and most widely used strategy analysis systems is the Flanders System of Interaction Analysis (FSIA) (Flanders, 1970). In this system teacher behaviors which encourage or discourage student freedom are observed and coded into ten different categories. The system can be used as a simple checklist of behaviors that were or were not present. Or, it can be turned into a ten category by ten category matrix and scored to show sequential patterns or chains of instructional behavior. Coded responses are reported as percentages and provide a snapshot of what occured in the classroom.

Unique science learning environments, such as laboratories and science instructional strategies such as inquiry teaching have necessitated the development of strategy analysis systems designed specifically for science instruction. While these science instruments have many elements in common they do differ on a number of conceptual and contextual dimensions. A few of these dimensions will be identified and representative instruments described.

Categorical-linear

Strategy analysis systems can be categorized on the basis of their use of nominal or continous data. Behavior checklists are an example of a nominal or non linear system. Checklists can be used to determine the frequency of specific instructional behaviors, but not the relative position or change along a continuum of, for example, less inductive to more inductive teaching behaviors.

The Instrument for Analysis of Science Teaching (IAST Base) (Hall 1970) is an example of categorical strategy analysis system. In this system, eight teacher behaviors and six student behaviors are described. As these behaviors are observed, a tally is made. These tallies are then summarized into a frequency distribution of teaching behaviors. In comparison the Teaching Strategy Observational Differential (TSOD) (Anderson, Struthers and James 1974) uses a linear approach. The TSOD provides a single rating of a teaching style representing a position on a continuum from one (expository/indirect) to ten (inductive/indirect). The placement order of numbered teacher behaviors on the IAST has no meaning while it does take on meaning on the TOSD, i.e. the higher the number the more inductive/indirect the teacher. Through the construction of a matrix and development of ratios, the IAST and other nominal systems may be able to be used to generate continuous data. However many of these conversion procedures lack the basic underlying linear concept and lead to difficulties in interpretation.

Descriptive-Evaluative

Descriptive strategy analysis systems are designed to record and measure observed behavior without assessing the quality of what is observed.

Evaluative systems are designed to assess type and quality of the observed teaching behaviors. The Science Laboratory Interaction Categories (SLIC) (Shymansky and Penick 1979) is an example of a descriptive observation instrument. SLIC is designed specifically for use in science laboratories. It contains 15 individual categories of teacher behavior and 10 categories of student behavior. Using this instrument an observer can code sequentially the behavior being observed, to whom the behavior is directed, and the gender of the individual to whom the behavior is being directed. In comparision the Teaching Strategy Quality Scale (TSQS) (Roadrangka and Yeany 1982) is an evaluative observation instrument which records teaching behavior and then assesses it on a quality scale. The TSQS uses the same behavior descriptors as the TSOD. Each of these behaviors is then rated against a 5 point criterion quality scale. This instrument provides information about not only what is going on in the classroom but also an assessment as to how well the strategies are being employed by the teacher.

Specialized-General

A number of science strategy analysis systems have been developed to measure specific teaching strategies and processes. One example is the Data Processing Observation Guide (DPOG) (Yeany and Capie 1979). The DPOG was designed to analyze student and teacher behaviors associated with teaching data analysis, communication and interpretation. The instrument allows for the coding of ten different data operations, and three teaching behaviors as well as identifying whether the teacher or student is involved with the data. The Question Category System for Science (QCSS) (Blosser 1973) is another example of a specialized system. As the name implies, this system is used to record teacher's science questions on an open to closed dimeansion

General strategy observation systems are those designed to measure generic teaching behaviors. The TSOD and the IAST are examples of strategy systems not limited to measuring one or two specific teaching behaviors.

Science Teacher Training Practices

While most strategy analysis instruments were constructed for and used as research instruments, it did not take long for teacher educators to begin using them for teacher training. Since most strategy analysis systems provide a mechanism for describing what is taking place in the classroom, they also can provide a means for individuals to analyze their own teaching. This self analysis can lead to better understanding of the teaching act and, coupled with practice, can lead to improvement in specific teaching skills like questioning and materials management.

Concomitant with the rise in strategy analysis has been a parallel, although somewhat delayed, change in teacher training expectations and in scientific technology. Competency based teacher education in which pre-service teachers are asked to exhibit competency in several specific teaching skills has arisen in part from the analytical approach to teaching that was sponsored by the behavior analysis researchers. Also, modern technology has introduced practical, inexpensive and easy-to-use audio and video taping devices which allow students to instantaneously hear or view themselves teaching. Coupling these devices with strategy analysis instruments has revolutionized science teacher training. Students can teach a lesson, view and analyze it, and subsequently reteach, practicing those skills that need practice. In addition the refinement of various practices such as microteaching, where students teach short lessons to

small groups of students and practice a few specific teaching skills, have helped to increase skill competency among teachers at all levels.

Typical practices

Variation in teacher training practices is quite wide. Thus, it comes as no surprise that most science teacher trainers use teaching behavior analysis instruments in a variety of ways. Yet it is still possible to synthesize a set of idealized steps that one might plan for optimum practice of any specific skill. While no one science educator might employ all parts of each step, the list below outlines most of the practices now in use.

I. Training in the use of the Instrument.

The first step in analysing teaching behavior is learning about the specific instrument and how to use it. The behavior categories on the instrument must be defined and those definitions refined, perhaps through class discussion and/or examples and models.

II. Analysis of Models

By analyzing models (both good and poor ones) students begin to internalize and operationally define each category. Within a group setting, students can discuss their ratings and compare them to a standard, if available. By striving for and achieving scoring consensus within the groups, students begin to believe in the validity of the instrument. This is an important prerequisite for beginning to rate their own teaching behavior.

Once mastery of a system is attained, further analysis of models can shape an individual's mental model of what is appropriate teaching behavior. This is an important step in changing overt behaviors. The

actual models that are used can take many forms. Video and audio tapes have proven quite successful, as well as film, written and live models.

III. Practice of Teaching Skills

The next step toward skill mastery is actual practice. The most cost-effective method presently used for practice is called microteaching. In this method a student plans a short science lesson (10 to 25 minutes) and teaches it to a small group (3 to 10 members) of peers. By identifying one or two skills as goals for the microteaching session, a student can focus all attention on the performance of relatively small but specific skills. Skill practice can also take place in a real classroom setting but is less efficient at the initial stages of development. In either case it is important that the lesson be recorded if further analysis is desired.

IV. Analysis of lessons

A. Self analysis

An important step in skill mastery is assessing a student's ability with a skill by using an objective observation instruments. Thus, the instrument used to rate model tapes is now used to rate the student's own performance that was video or audio taped. The tape when viewed "does not lie", and the observation instrument keeps the focus on the skill rather than distracting personal idiosyncracies.

B. Peer Analysis

Teaching performance is also improved through feedback from peers. Using objective observation instruments is useful for this

purpose. In addition some general evaluative comments regarding overall performance can be helpful.

C. Supervisor feedback and analysis.

Viewing a tape of a lesson with a teacher training expert is invaluable. Where a student might overlook certain behaviors, trained experts rarely do so. Thus, time spent with individual students viewing and discussing their lessons can be exceedingly worthwhile.

V. Reteaching

More than one experience using strategy analysis instruments and microteaching techniques is almost a necessity. Too much time and energy is wasted during a first experience on extraneous variables such as learning how to use a strategy analysis instrument or criticising posture or voice quality. Some experts suggest that students practice one skill such as asking higher level questions, go through a complete analysis cycle, and then practice the same skill again in another session. Others feel that one session per skill is adequate.

Results of Research on Training Effectiveness

The research on the use of teaching strategy analysis to train science teachers can be grouped into categories similar to those presented above. A review of studies indicates that some investigators have assessed the influence of teachers being made aware of particular behaviors through the study of behavior analysis instruments. Others have researched the effects of analyzing model lessons on the behavior of the subjects. Still others have focused on the influence of practicing certain behaviors

(usually in a microteaching situation) followed by self analysis of the lesson. A last research focus has been peer or instructor feedback on the teachers behaviors presented.

Study of an Analysis System

Yeany (1977) found that simply studying a system for measuring direct through indirect teaching strategies was not enough to influence the behaviors of elementary science teachers. On the other hand, Riley (1978) reported an effect of studying a question classification system on the questioning behaviors of teachers. These teachers asked higher level questions when compared to a control group. Similarly Kirk and Amidon (1976) reported that study of a verbal interaction analysis system influenced how student teachers handled class discussions. Also, Roush and Kennedy (1971) concluded that teachers who learned to use the Flanders Interaction Analysis System became more indirect in their classroom responces.

The Effects of Modeling

Gallagher (1967) wrote that in the absence of specific instruction and analysis, most teachers teach as they were taught. Their teaching is rarely a "thought through" skill. Statements such as this imply the existence of a modeling phenomenon. Murray and Fitzgerald (1973) found that a single brief exposure to a video taped model demonstrating a specific set of behaviors was sufficient to bring about behavioral change in student teachers. Zevin (1973) reported a change in the behavior of teachers who received training from an instructor who regularly modeled inquiry behavior. Similarly, studies by Lange (1971), using video tapes and White (1972), using audio tapes, indicated that the behaviors of experimental teachers

became more like the presented models. On the other hand, James (1971) and Yeany (1977) reported results where the development of inductive science teaching strategies was not facilitated by viewing video-tapes and films of models using inductive/indirect style.

A combination of the above two types of training has served as a logical focus of science teacher training research studies. Koran (1971) and Lamb (1977) reported an effect of analyzing model question episodes on the questioning behaviors of pre-service and in-service science teachers. In a study involving process skill teaching behaviors, Yeany, Okey and Capie (1978) concluded that analyzing models of process skill behaviors of students and teachers positively influenced the classroom behaviors of secondary science teachers. The Yeany (1977) study supported the above conclusion in reference to inductive science teaching strategies of elementary teachers.

The Effects of Self-Analysis

Analyzing one's own teaching behaviors has proven to be an effective training method. Harris, Lee and Pigge (1970) reported that both personal mannerisms and classroom techniques of elementary teachers were improved through the self analysis of micro-lessons. Likewise, Riley (1980) showed that self-analysis led to desired changes in the inductive teaching strategies of middle school science teachers. Yeany, Okey and Capie's (1978) study supported these findings for process skill teaching in secondary teachers. Miller (1980) involved elementary, middle and secondary science teachers. Her results showed that by combining model and self analysis both the classroom management behaviors and pupil achievement was positively influenced.

The Effects of Feed-Back

After investigating the effects of self-analysis, some researchers have inquired into the effects of peer or instructor feed-back related to teaching behaviors. Yeany (1978) compared supervised (feedback) analysis with self-analysis and reported a two-fold increase in effect in favor of supervised analysis. Also, in the James (1971) study, video-taped feedback with supervision facilitated the development of inductive science teaching strategies to a higher degree than model viewing.

Integrating the Research

Most of the research results are supportive of the training method outlined in various sections of the paper. The question then becomes: which ones are more effective than others? Yeany and Porter (1982) presented a meta-analysis of research related to this question. They supported the conclusion that all the training methods positively impacted the behaviors of science teachers. But, through the meta-analysis techniques, concluded that the magnitude of impact occurs in the following order.

Method	Effect Size	Index of Effectiveness
Analysis with Feedback	2.30	3.2
Analyzing Models	1.15	1.6
Observing Models	1.10	1.5
Study of Analysis System	.79	1.1
Self Analysis	.72	1.0

As can be noted the analysis with feedback approach is the most effective. Using models has an intermediate impact and simply studying an analysis system and self analysis is at the bottom. The "index of effectiveness" was calculated by setting the effect of the self analysis equal to 1 and then comparing the others to this base.

Summary

The development of a variety of strategy analysis observation systems has resulted in the availability of valid and reliable measures of teaching behavior. Many of these instruments have been used as curricular tools in the training of science teachers. Research results indicate the efficency of strategy analysis employed in the assessment of classroom behavior and as a means for training preservice teachers in the use of these behaviors.

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